XIth International Symposium: Quantum Theory and Symmetries(QTS)
July 1-5, 2019
Contributed talk - Session on Quantum Computing & Quantum Information Theory

Unitary designs and scrambling in random quantum circuits

Nicholas Hunter-Jones*

nickrhj@pitp.ca

We study scrambling and the onset of Haar-randomness in quantum circuits, 1d chains of qudits time evolved by random 2-site unitaries. Random circuits are minimal models of local quantum chaotic dynamics and are invaluable constructions in both quantum information theory and in the study of many-body physics. Regarding the later, they are solvable models of operator growth and scrambling/thermalizing many-body systems, and can can be used to study the emergence of diffusive hydrodynamics. From a quantum information perspective, random quantum circuits are efficient constructions of approximate unitary k-designs and are relevant to recent proposals for the demonstration of quantum supremacy. In this talk, we will describe a statistical mapping which allows for exact calculations in random circuit models. In particular, we will show that random circuits form approximate k-designs in essentially optimal depth, improving on some previous bounds. Moreover, in the stat-mech picture, the onset of Haar-randomness gives a nice physical interpretation. Using similar techniques, we also reinterpret previously derived thermalization and scrambling time scales in this framework.

*Department of Theoretical physics/Quantum information, Perimeter Institute, 31 Caroline St N, Waterloo, ON N2L 2Y5, CANADA